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Assessment Highlights



Grade 9 Mathematics Achievement Testing Program

June 1992

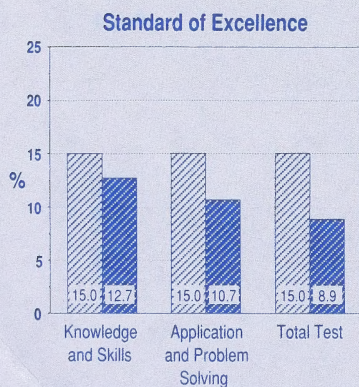
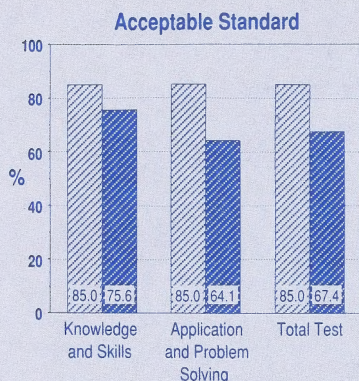
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Percentage of Students Achieving:



Achievement Standard *
 Actual Results **

* the percentage of students in the province expected to meet the acceptable standard and the standard of excellence

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Who Wrote the Test?

Students enrolled in the regular Grade 9 Mathematics program were expected to write the 1992 achievement test. A total of 27 888 students wrote the test in English.

What Was the Test Like?

The test had 50 questions in five content areas: Number Systems and Operations, Ratio and Proportion, Measurement and Geometry, Data Management, and Algebra. The questions measured four cognitive levels: Content Knowledge and Quantitative Literacy, Procedural Knowledge, Conceptual Understanding, and Problem Solving. The cognitive levels were grouped under *Knowledge and Skills* (18 questions) and *Application and Problem Solving* (32 questions).

The test was divided into two parts. Part A had 40 multiple-choice questions, each with four alternatives. Part B had 10 numerical-response questions, which required students to calculate the answer and then record it on the separate answer sheet.

How Well Did Students Do?

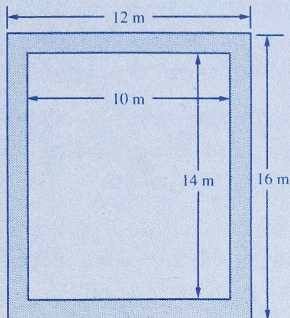
As shown by the graphs, students did not do as well as expected in *Knowledge and Skills* or in *Application and Problem Solving*. Students' weak performance in mathematics is most evident in the difficulty they had solving problems involving multi-step solutions. Students achieving the acceptable standard and the standard of excellence were more successful with the knowledge and skills questions than with questions requiring application.

Has Achievement Changed Since 1984?

A special study of changes in achievement over time was conducted as part of the provincial assessment. Preliminary results showed that achievement in 1992 was higher than in 1984 but they have not changed significantly since 1988. Details will be reported in the 1992 *Achievement Testing Program Provincial Report*.

Use the information below to answer questions 23 and 24.

The shaded region of this diagram represents the top view of a trench that a contractor dug.



24. The contractor was required to cover the bottom of the trench with plastic before further construction could be done. If one roll of plastic contains 10 m^2 , how many rolls did the contractor need?

22.6 A. 5
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- 6s. A cargo plane can hold 6 trucks and 7 jeeps, or 8 trucks and 4 jeeps. If the plane is loaded with jeeps only, then what is the maximum number of jeeps it would likely hold?

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Question 34 required students to solve a condition for a variable in terms of another variable and a constant. Most students achieving the standard of excellence correctly answered this question; however, some selected alternative B.

Numerical-response question 6s required students to use a ratio to solve a practical problem. Students achieving the standard of excellence had difficulty solving this question.

Students who achieved the standard of excellence demonstrated more success in solving multi-step problems than other students did. Specifically, students achieving the standard of excellence could

- solve practical problems (question 24)
- solve place value problems involving divisibility rules (question 9)
- solve and check conditions (question 34)
- use patterns to solve problems

However, these students had difficulty

- solving problems with two variables
- solving problems involving computation with ratios (question 6s)

Performance Based Assessment

In addition to answering the multiple-choice and numerical-response questions on the achievement test, 504 randomly selected students from a sample of schools throughout the province were involved in performance-based assessment.

Students were asked to solve six real-life practical problems and were given concrete materials to solve these problems. Markers used holistic scales for problem solving and communication to rate student responses. The following table gives preliminary results from the assessment.

Performance Based Assessment	Problem Solving	Communication
Students Who May Be Achieving Beyond Level	16.9%	15.9%
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The results show that

- about half the students were not able to solve open-ended problems successfully
- those students who are able to apply the problem solving model can also clearly communicate the process and results in writing
- successful students used a wide range of strategies in problem solving, and preferred to solve problems using the concrete mode rather than the symbolic
- students were more successful in solving problems when manipulatives could be used directly to solve the problem

Performance-based assessment will continue to be a component of all achievement tests in grades 3, 6, and 9. A more detailed analysis of student performance on each of the tasks will be available in the 1992 *Achievement Testing Program Provincial Report*.

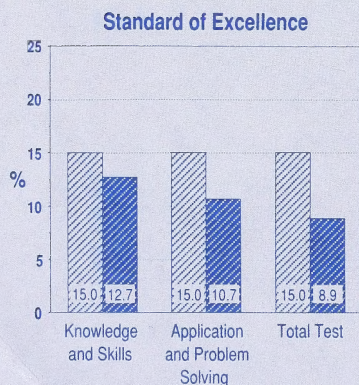
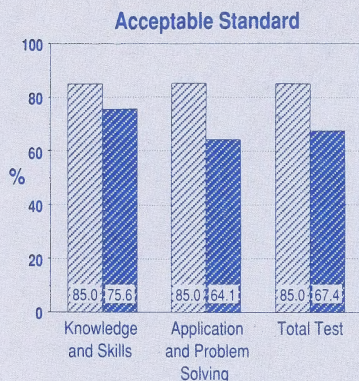
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Test Blueprint

Each question on the test blueprint is classified according to the curriculum component and the cognitive level demanded by the question. The test blueprint shows the distribution of questions according to these classifications.

	Reporting Category				
	Knowledge and Skills		Application and Problem Solving		
Curriculum Component	Content Knowledge and Quantitative Literacy	Procedural Knowledge	Conceptual Understanding	Problem Solving	Total Number of Questions and Test Emphasis
Number Systems and Operations	1, 2, 10	1s,* 2s	3, 4, 5, 6, 7	8, 9, 5s	13 (26%)
Ratio and Proportion	11, 16	4s	12, 13, 14	15, 3s, 6s	9 (18%)
Measurement and Geometry	17, 22	18, 19	20, 21, 7s, 8s, 9s	23, 24	11 (22%)
Data Management	29	25	26, 27, 28, 30	10s	7 (14%)
Algebra	31	32, 33, 34	35, 36, 37, 38	39, 40	10 (20%)
Total Number of Questions and Test Emphasis	9 (18%)	9 (18%)	21 (42%)	11 (22%)	50 (100%)

*s—numerical-response question

Test Results

The table shows question-by-question results and the keyed answers.

Multiple-Choice and Numerical-Response Questions

Question	Key	Difficulty*	Question	Key	Difficulty	Question	Key	Difficulty
1	A	60.9	18	C	67.5	35	D	52.2
2	B	76.1	19	C	71.0	36	A	47.8
3	D	50.0	20	D	53.1	37	C	65.9
4	D	55.5	21	A	67.3	38	A	41.7
5	B	63.6	22	C	53.4	39	A	76.0
6	C	56.4	23	B	50.0	40	C	55.3
7	A	70.1	24	B	50.1	1s	0891	62.0
8	A	20.8	25	C	56.0	2s	0004	72.3
9	D	44.9	26	D	59.5	3s	0092	45.0
10	D	66.1	27	B	63.4	4s	0080	54.5
11	A	72.4	28	C	58.0	5s	0076	21.6
12**	deleted		29	C	62.3	6s	0016	27.2
13	D	74.6	30	D	61.2	7s	1260	48.5
14	C	57.8	31	B	70.0	8s	0123	46.7
15	B	49.3	32	B	52.7	9s	0009	47.9
16	C	84.0	33	C	48.1	10s	0170	68.0
17	B	46.8	34	A	43.7			

*Difficulty—percentage of students answering the question correctly

**Question 12 was dropped from the Problem Solving component of the test because both A and B were possible answers.

Observations

The following is a discussion of specific areas of strength and difficulty for Grade 9 students. Sample questions are provided to highlight the strengths and weaknesses of students achieving the acceptable standard and the standard of excellence. For each sample question, there is an asterisk beside the correct answer. The percentage of students choosing each alternative is also provided.

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4	D	55.5	21	A	67.3	38	A	41.7
5	B	63.6	22	C	53.4	39	A	76.0
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Acceptable Standard—Sample Questions and Commentary

Generally, the Grade 9 teachers who reviewed and set standards for the test felt that it was a good reflection of the Grade 9 Mathematics program. Test emphases were on understanding concepts and applying them in context, using real-world situations and concrete, pictorial, and symbolic modes of learning. Although the program has been in operation for four years, some teachers felt that they need more time to fully implement the philosophy.

Question 7 required students to recognize the scale on the number line and the rational numbers of the points marked. Students achieving the acceptable standard can do this.

Question 15 required students to find the amount of gold in a bracelet by using a ratio and then calculating the value of the gold. Students achieving the acceptable standard had difficulty solving this multi-step problem. Too many were attracted to alternative C.

Question 19 required students to measure an obtuse angle using the right-hand scale. Students achieving the acceptable standard can do this.

Numerical-response question 10s required students to form a proportion and solve it. Students achieving the acceptable standard had little difficulty doing this.

Overall, students achieving the acceptable standard were able to solve knowledge and procedural problems such as

- working with number line (question 7)
- working with scientific notation
- using simple proportion (question 10s)
- estimating
- measuring angles (question 19)
- recognizing like terms and geometric constructions
- solving exponential equations

However, these students had difficulty

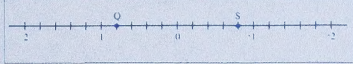
- using patterns to solve problems
- knowing the meaning of terms such as range, probability, median
- manipulating a formula with two variables
- solving inequality conditions
- solving multi-step problems (question 15)

Standard of Excellence—Sample Questions and Commentary

Question 9 required students to apply place value and the rules of divisibility. Students achieving the standard of excellence readily answered this question.

Question 24 required students to find the area of the shaded figure and consider the practical significance of the remainder in division. Students achieving the standard of excellence readily answered this question.

Use the information below to answer question 7.



7. The rational numbers located at points Q and S respectively are

- 70.1 *A. -0.8 and -0.8
5.5 B. -1.2 and -0.8
2.6 C. -1.2 and -1.2
21.7 D. -0.4 and -0.4

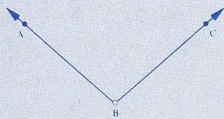
Use the information below to answer question 15.

The proportion of gold in jewellery and coins is measured in karats (K), with 24K representing pure gold.

15. The value of pure gold is \$16.50/g. If a gold bracelet is marked 18K and its mass is 60 g, what is the value of the gold in the bracelet?
- 7.9 A. \$278.20
49.3 *B. \$742.50
39.6 C. \$990.00
3.0 D. \$1237.50

19. The measure of $\angle ABC$ is

- 2.6 A. 37°
20.7 B. 82°
71.0 *C. 98°
5.6 D. 112°



- 10s. A factory inspector chooses 10 radios at random from an assembly line. She tests all 10 and finds that 2 of them are defective. On the basis of this sample, about how many defective radios could be expected in a batch of 850?

68.0 Solution 0170

9. The 3-digit number $2M3$ is added to 326 to give another 3-digit number, $5N9$. If $5N9$ is divisible by 9, then M is

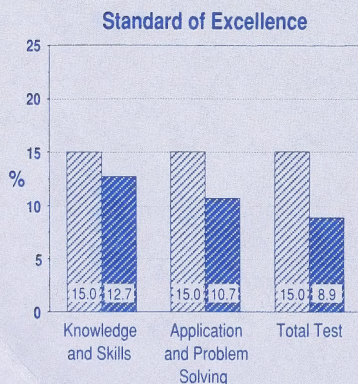
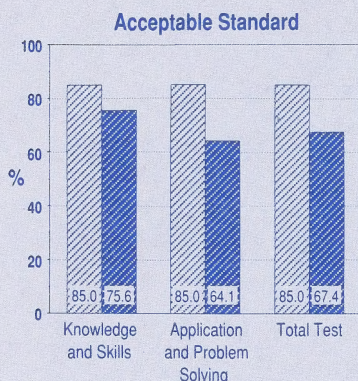
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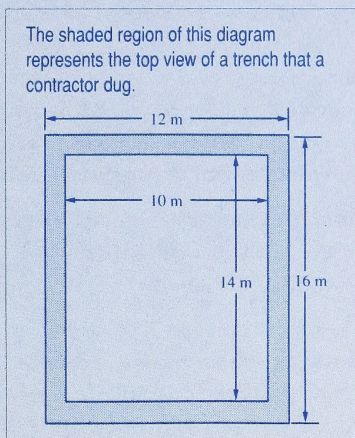
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Questionnaire

In June 1992, Grade 9 Mathematics teachers and students from all parts of the province participated in a study designed to look at relationships among some of the various contexts for learnings that affect student achievement.

The student questionnaires reveal that students generally feel that

- the answer is more important than the method used in problem solving
- mathematics is useful in everyday life and necessary for getting a good job
- they can persist but confidence is rather low

The teacher questionnaires reveal that teachers generally

- encourage a variety of problem-solving strategies
- integrate problem solving through the strands
- do not use manipulatives to a great extent
- are enthusiastic in their approach toward problem solving

More information will be available in the *Achievement Testing Program Provincial Report*.

Issues

Results from achievement tests, performance-based assessment, and teacher and student questionnaires indicate that the Grade 9 Mathematics program is not being fully implemented. Students' poor performance was demonstrated in both the achievement test and the performance-based assessment. Students are more successful in problem solving when they can use manipulatives directly to solve a problem, and they prefer problem-solving strategies in a concrete mode rather than a symbolic mode. To fully implement the philosophy of the mathematics program, the use of manipulatives would need to be an integral part of the classroom; yet responses to the questionnaire exploring contexts for learning mathematics shows that very few manipulatives are being used in mathematics classes. In spite of the focus placed on use of manipulatives in developing problem-solving skills in the new *Program of Studies* in 1988, it does not appear that teachers have integrated the use of manipulatives into their instructional programs.

For further information, contact Kathleen Melville, Assessment Specialist, at 427-0010.

